MATERIALS BUREAU

TECHNICAL REPORT 92-1

PERFORMANCE OF DOLOMITES AS HIGH FRICTION AGGREGATES

INTERIM REPORT

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NEW YORK STATE DEPARTMENT OF TRANSPORTATION
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PERFORMANCE OF DOLOMITES AS HIGH FRICTION AGGREGATES

Prepared By

William H. Skerritt
Engineering Geologist I

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WAYNE J. BRULE, DIRECTOR

NEW YORK STATE DEPARTMENT OF TRANSPORTATION
1220 WASHINGTON AVENUE, ALBANY, NY 12232

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TABLE OF CONTENTS

	Page
Background	1
Analysis of Performance Data	1
Low Residue Dolomites	1
High Residue Dolomites	2
Summary	2
Tables: Pavement Friction Inventory Site Data	
Table 1: Wappinger Dolomite	3
Table 2: Lockport Dolomite (Low Residue)	3
Table 3: Other Dolomites	4
Figure 1: Schematic Diagram of Pavement Polishing	6
Figure 2: Correlation Chart Between Lane AADT and Reported AADT	7
Figures 3-6: Plots of Average FN_{40} vs. Lane AADT	
Figure 3: Dolomites with less than 15% A.I.R.	8
Figure 4: Dolomites with A.I.R. above 20% & Dolomites with A.I.R. Between 15 & 20%	9
Figure 5: Siliceous Limestone & Siliceous Dolomite	10
Figure 6: Sandstone, Siltstone, Quartzite	11

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PERFORMANCE OF DOLOMITES AS HIGH FRICTION AGGREAGTES

Background:

When the requirements for high friction aggregates in asphalt concrete mixtures were under development in the mid 1960s, the performance of dolomite aggregate was recognized as different from, and better than, that of limestone aggregate. The performance superiority of unblended, low residue dolomites over unblended, low residue limestones was confirmed by pavement friction tests. Since then, all dolomites have been accepted for use as high friction aggregates in the Department's standard top course mixes.

Pavement friction data from the Department's Pavement Friction Inventory Program, begun in 1980, as well as data from previously conducted research (Engineering Research Bureau, 1973-5) now shows a distinct difference in performance between pavements containing high residue dolomites and some low residue dolomites. The results of this testing are tabulated in tables 1-3.

The analysis of this data is based on the pavement polishing scheme shown in Figure 1. The concept of a "terminal polish" provides a basis for using average friction numbers to represent each site tested (Gray and Renninger, 1966; Diringer, 1990). This analysis introduces the concept that the friction level of a pavement site at terminal polish, is dependent, in large part, upon the traffic volume, expressed in terms of lane vehicle passes per day, that the pavement experiences.

Analysis of Performance Data:

Pavement friction tests were performed on 71 sites representing dolomites quarried throughout New York State. The insoluble residue content of these dolomites represent the entire range available, and were tested in both high and low traffic volume pavements, where appropriate sites were available. This analysis compares the performance of low residue dolomites, having acid insoluble residue contents of 15% or less, with that of high residue dolomites, having acid insoluble residue contents greater than 15%.

Low Residue Dolomites (A.I.R. 15% or less):

The Wappinger Dolomite is shipped into the New York City area and is, therefore, frequently used in asphalt concrete top couarse subjected to very high traffic volumes. It is the only low residue dolomite regularly used in such applications. Friction testing has shown that the Wappinger, quarried in the southern Hudson Valley and having an acid insoluble residue content in the 9-14% range (Table 1), provides adequate friction in low traffic volume applications The same Wappinger Dolomite when used in high traffic volume pavements yields friction numbers considered inadequate by design standards (see Figure 3).

The Lockport, a dolomite quarried in central and western New York, typically has an insoluble residue content of less than 10% (Table 2). One member of the lockport Formation, the Penfield, contains from 25 to 50% insoluble residue, and will be discussed with the high residue dolomites. The data (Figure 3) shows that the Lockport Dolomite provides adequate friction in low traffic volume applications.

Dolomites from other formations were tested as well. The Beekmantown, quarried in northern St Lawrence County, typically contains between 5 and 14% insoluble residue (Table 3). These, and other similar dolomite sites, sites, fell into a similar data distribution (Figure 3) as the Wappinger and low residue Lockport data, in low traffic volume pavements.

All these low residue dolomites share a common mineralogy and contain similar amounts of insoluble residue. With respect to pavement friction, they all perform similarly at low traffic volumes* and may, also, perform similarly at high traffic volumes*. Although pavements containing low residue Lockport, Beekmantown, and othe low residue dolomites, were sought in high traffic volume applications for the Inventory Program. none were found that have Lane AADTs greater than 5,000 vehicle passes per day.

High Residue Dolomites (A.I.R. greater than 15%):
Dolomites having high insoluble residues are shown plotted in Figure 4. These include dolomites from the Penfield Member of the Lockport Formation, mentioned previously, as well as other high residue dolomites quarried in the Mohawk Valley and upper Hudson Valley. The distribution of data is similar to that of siliceous limestones, all of which have insoluble residues greater than 20% (Figure 5), and of sandstones (Figure 6). Even high traffic volume pavements (up to 10,000 lane vehicle passes per day) are performing well. The sandy nature of these high residue dolomites overcomes the polishing nature of the pure dolomite.

Summary:
All those sites containing dolomites having acid insoluble residues greater than 15% are providing adequate friction in both low and high traffic volume pavements.

Sites containing dolomites having acid insoluble residue contents less than 15% are providing adequate friction in low traffic volume pavements.

Within the population of low residue dolomite sites, the Wappinger Dolomite is failing to provide friction that meets the minimum design requirements in high traffic volume applications.

* Low traffic volume is herein defined as 3,000 lane vehicle passes per day or less; high traffic volume is greater than 3,000 lane vehicle passes per day. The relationship between Lane AADT, expressed in lane vehicle passes per day, and AADT, as traffic volume is generally reported, is shown in the correlation chart (Figure 2).

Table 1

PAVEMENT FRICTION INVENTORY SITES

WAPPINGER DOLOMITES

Site No.	Acid Insoluble Residue	Lane AADT	Average FN_{40}
*8-3.2	9	2,500	41
8-9	14	5,300	29
8-10	13	2,000	42
8-12	11	1,500	41
8-13	9	1,500	37
10-4	10	19,200	29
10-5	10	24,800	23
10-6	10	13,600	30
10-8	10	7,000	30

Table 2

PAVEMENT FRICTION INVENTORY SITES

LOCKPORT DOLOMITES

Site No.	Acid Insoluble Residue	Lane AADT	Average FN_{40}
*3-5.1	5	2,100	34
*3-5.2	1	4,000	24
*3-5.3	5	2,800	44
*3-5.4	5	700	44
*3-5.5	5	1,400	47
*3-8.1	1	3,800	37
3-20	4	1,500	40
*4-9-1	6	1,800	37
*4-9.2	5	1,400	46
4-11	12	3,100	45
5-4	5	3,000	48
*5-4.1	5	1,400	47
*5-5.1	4	2,800	49
*5-5.2	4	3,000	37
*5-5.2A	5	2,100	45
5-10	8	1,500	54
5-11	7	700	49
5-12	2	5,200	37
5-13	6	1,600	38

* Site tested by the Engineering Research Bureau in 1973-5

Table 3

PAVEMENT FRICTION INVENTORY SITES OTHER DOLOMITES

Site No.	Acid Insol. Res.	Lane AADT	Average FN_{40}
1-4	11	300	52
1-7	15	1,300	46
1-16	20	10,200	43
1-20	18	7,900	42
1-21	28	6,200	46
1-22	18	6,400	40
2-1	17	400	57
2-2	17	700	53
*2-5.1	19	5,000	47
*2-5.4	15	4,000	36
*2-6.1	25	6,500	47
*2-6.3	28	3,800	42
*2-10.1	22	3,800	40
*2-10.2	28	7,700	42
*2-10.3	25	2,500	56
*2-10.4	25	2,800	49
*2-14.1	16	2,500	42
*2-14.2	14	3,000	44
*4-4.1	20	1,100	44
*4-5.1PL	22	800	51
*4-5.1DL	22	1,700	46
*4-6.1	32	5,600	45
*4-6.2	19	5,600	42
*4-6.3PL	35	6,500	47
*4-6.3DL	35	10,800	42
4-7	43	8,600	51
4-14	36	2,800	47
4-15	37	2,600	44
4-16	21	1,800	57
4-17	39	2,100	52

* Site tested by the Engineering Research Bureau in 1973-5

Table 3 (continued)

Site No.	Acid Insol. Res.	Lane AADT	Average FN_{40}
*7-1.1	5	2,800	42
7-5	11	600	39
7-6	14	1,900	39
7-7	11	300	52
*7-8.2	20	4,000	43
*7-8.1	18	4,000	41
*7-8.3	18	4,000	43
*8-3.1	17	2,100	47
*8-9.1	36	9,200	41
8-11	16	2,700	41
8-14	39	1,500	43

* Site tested by the Engineering Research Bureau in 1973-5

Figure 1: SCHEMATIC DIAGRAM OF PAVEMENT POLISHING

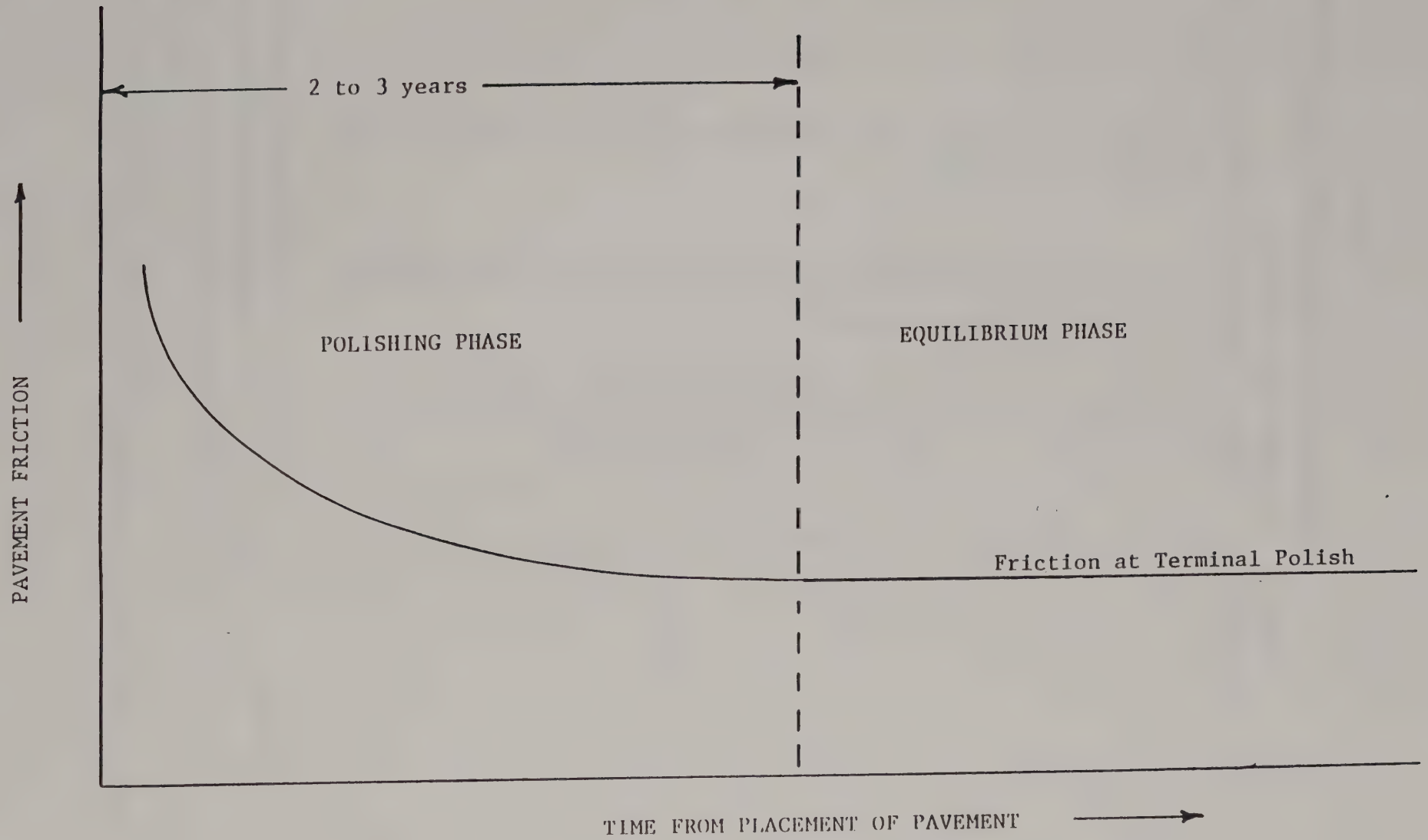


Figure 2

CORRELATION CHART BETWEEN LANE AADT AND REPORTED AADT

LAADT * (thousands)	Reported AADT (thousands)** 2-lane	4-lane	6-lane	Traffic Description
0.5	1.0	1.7	2.5	
0.6	1.2	2.0	3.0	
0.7	1.4	2.3	3.5	
0.8	1.6	2.6	4.0	
0.9	1.8	3.0	4.5	
1.0	2.0	3.3	5.0	Low
1.2	2.4	4.0	6.0	
1.4	2.8	4.7	7.0	
1.6	3.2	5.3	8.0	
1.8	3.6	6.0	9.0	
2.0	4.0	6.7	10	
3.0	6.0	10	15	
4.0	8.0	13	20	
5.0	10	17	25	
6.0	12	20	30	
7.0	14	23	35	High
8.0	16	26	40	
9.0	18	30	45	
10	20	33	50	
12	24	40	60	
14	28	47	70	
16	32	53	80	
18	36	60	90	
20	40	67	100	
22	44	73	110	Very High
24	48	80	120	
26	52	87	130	
28	56	93	140	
30	60	100	150	
32	64	107	160	
34	68	113	170	
36	72	120	180	
38	76	126	190	
40	80	133	200	
42	84	140	210	
44	88	146	220	
46	92	153	230	
48	96	159	240	
50	100	167	250	

* The one-way, driving lane AADT is considered to be 20, 30, and 50 percent of the Reported AADT respectively, for 6-, 4-, and 2-lane roads[4].

** This is the Average Annual Daily Traffic on the road, in all lanes, in both directions.

I This indicates the range of AADTs normally encountered for this kind of road.

Figure 3 : AVERAGE FRICTION NUMBER (AT 40 MPH) vs AVERAGE DAILY TRAFFIC (LANE AADT)
ALL DOLOMITES WITH LESS THAN 15% A.I.R. (A2a, A2b, A2c)

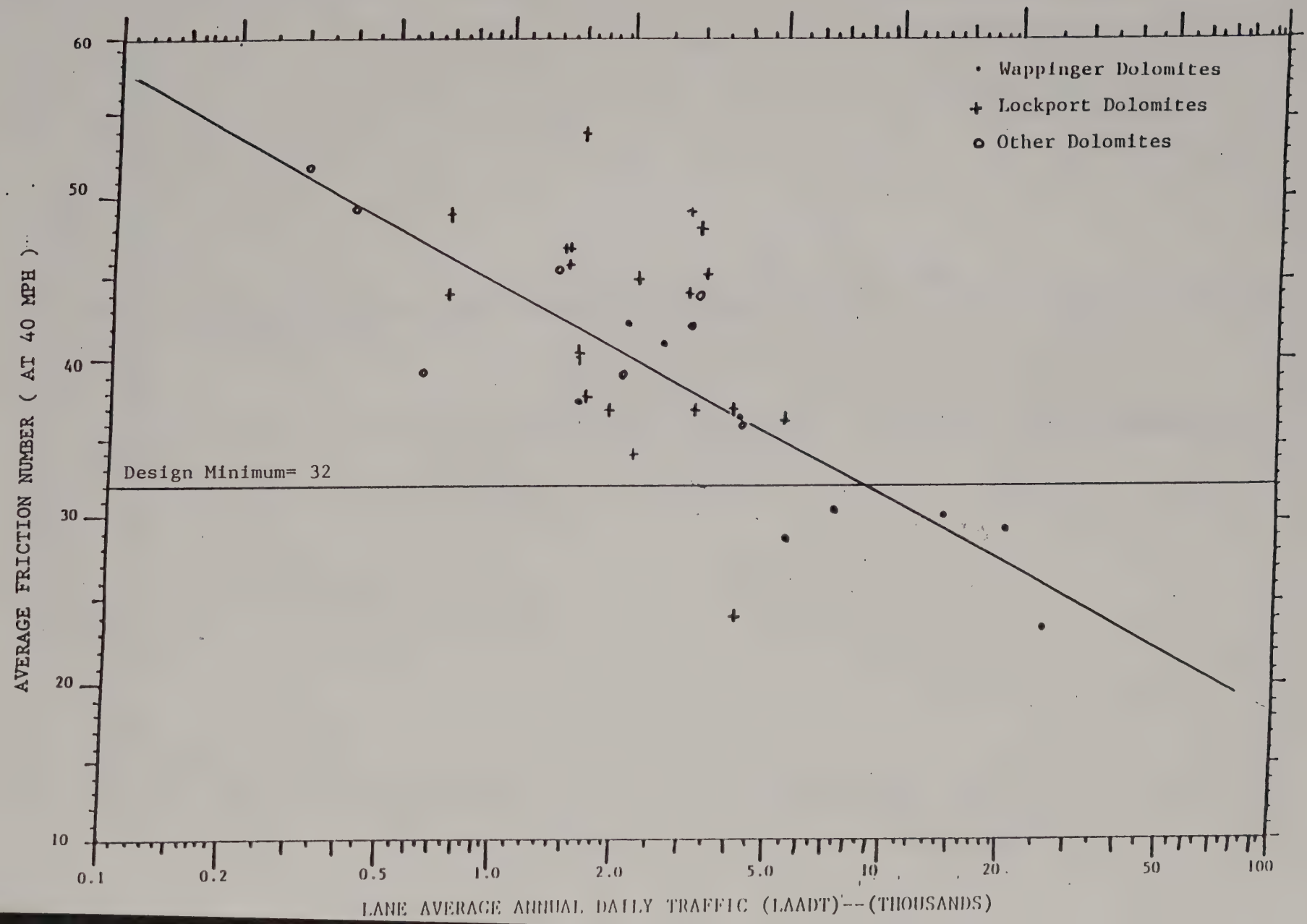


Figure 4 : AVERAGE FRICTION NUMBER (AT 40 MPH) vs DAILY TRAFFIC VOLUME (LANE AADT)
DOLOMITES WITH A.I.R. ABOVE 20% & DOLOMITES WITH A.I.R. BETWEEN 15 & 20%

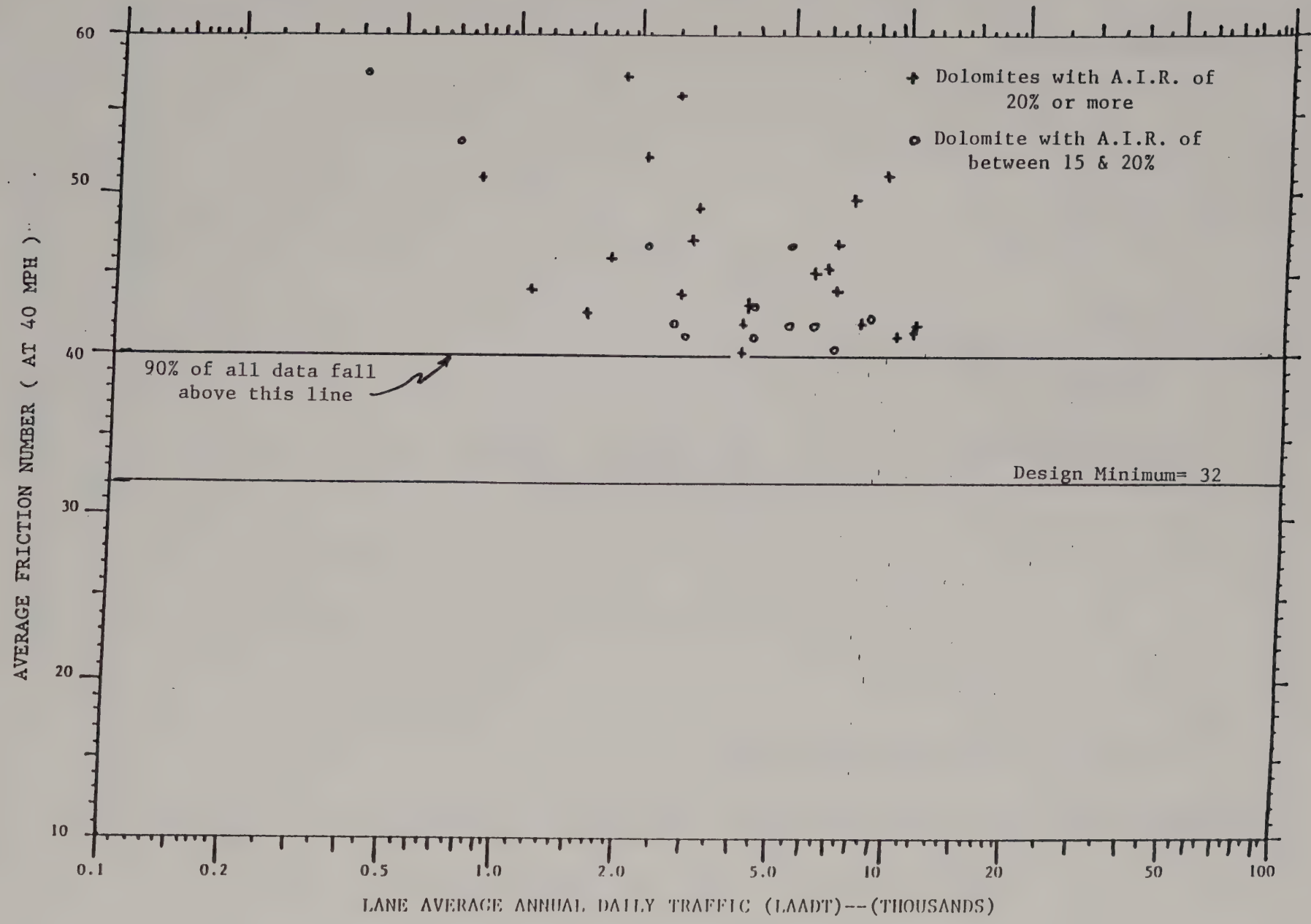


Figure 5 : AVERAGE FRICTION NUMBER (AT 40 MPH) vs AVERAGE DAILY TRAFFIC (LANE AADT)
SILICEOUS* LIMESTONE (B2a) & SILICEOUS* DOLOMITE (B2b)

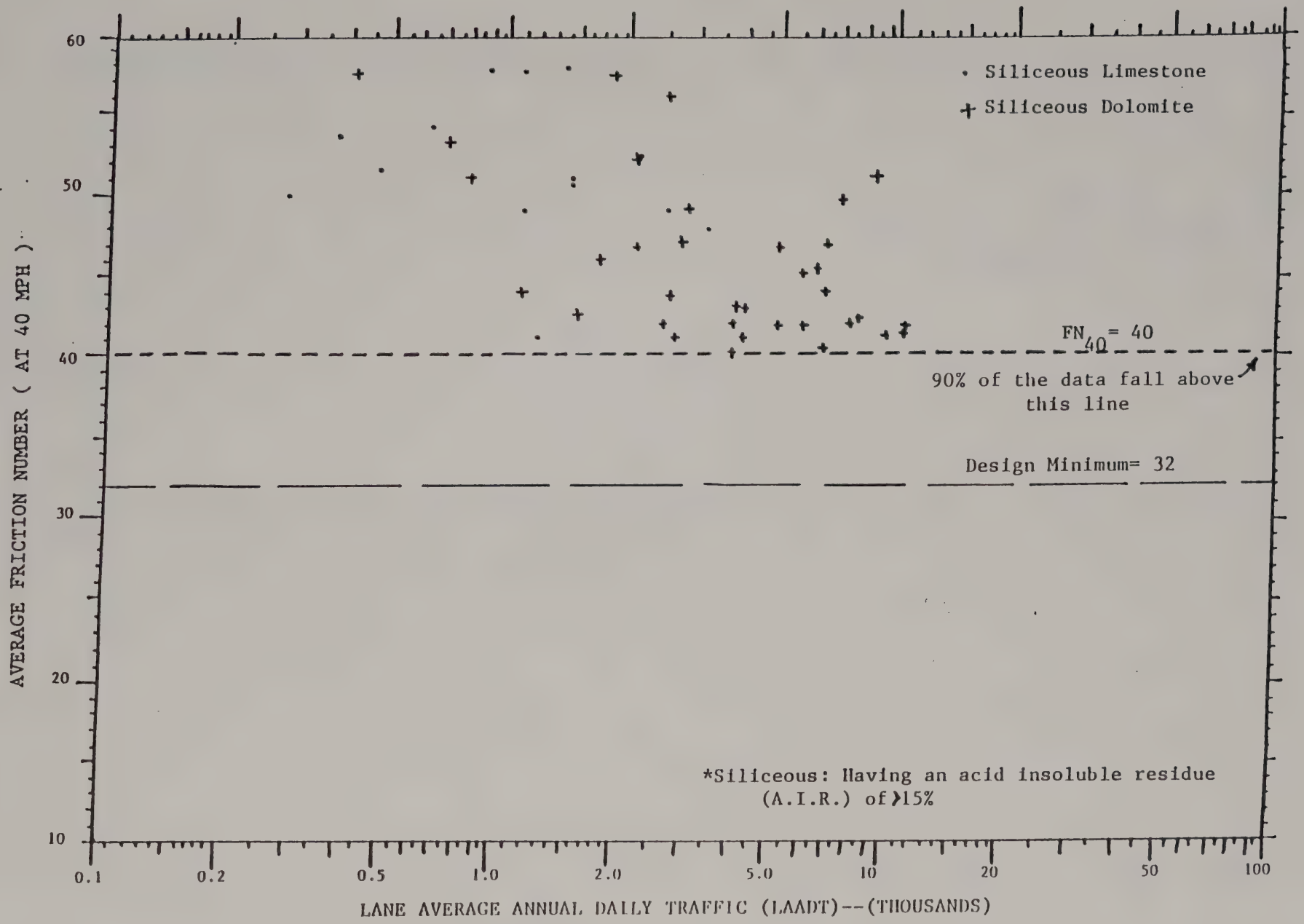
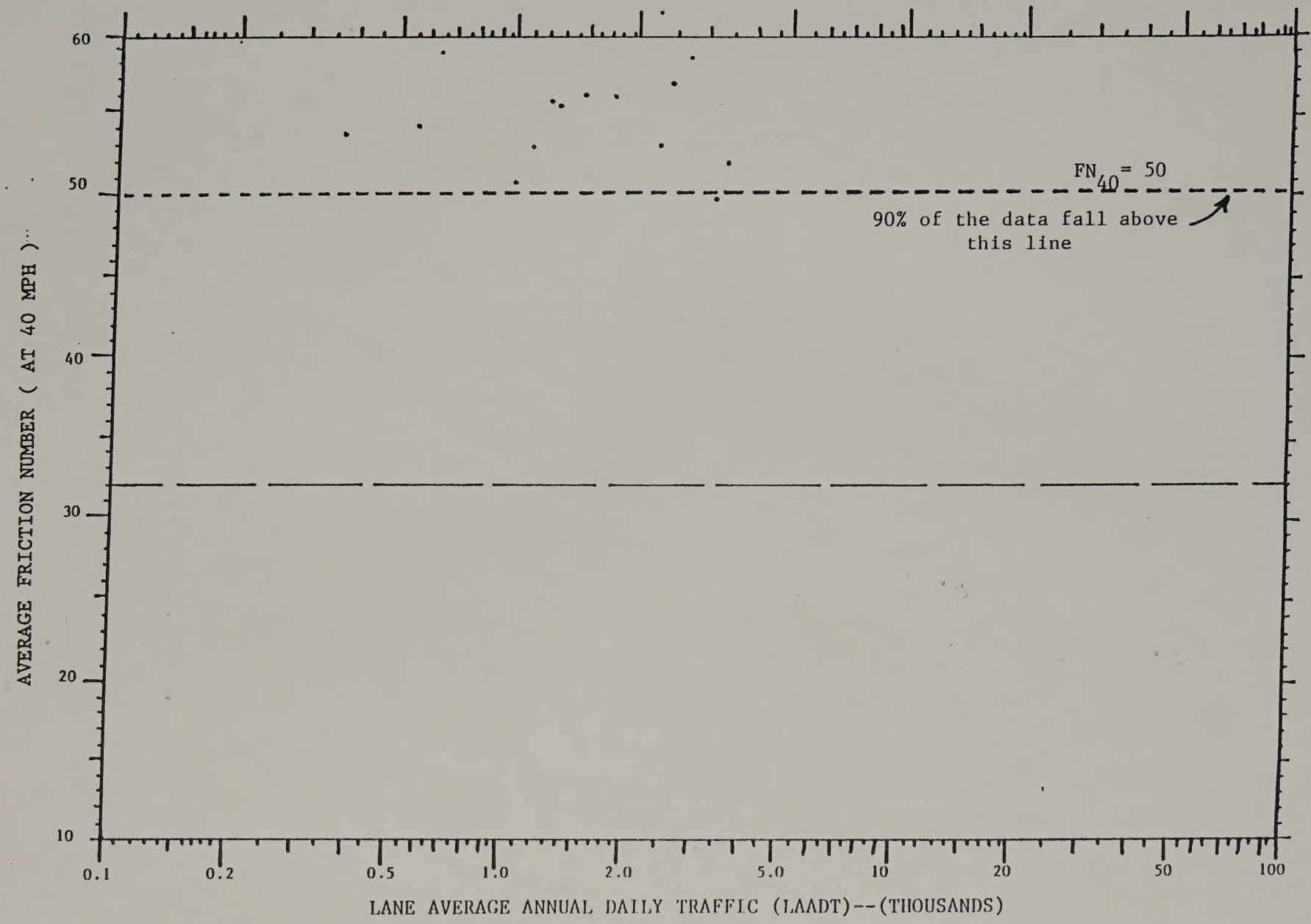
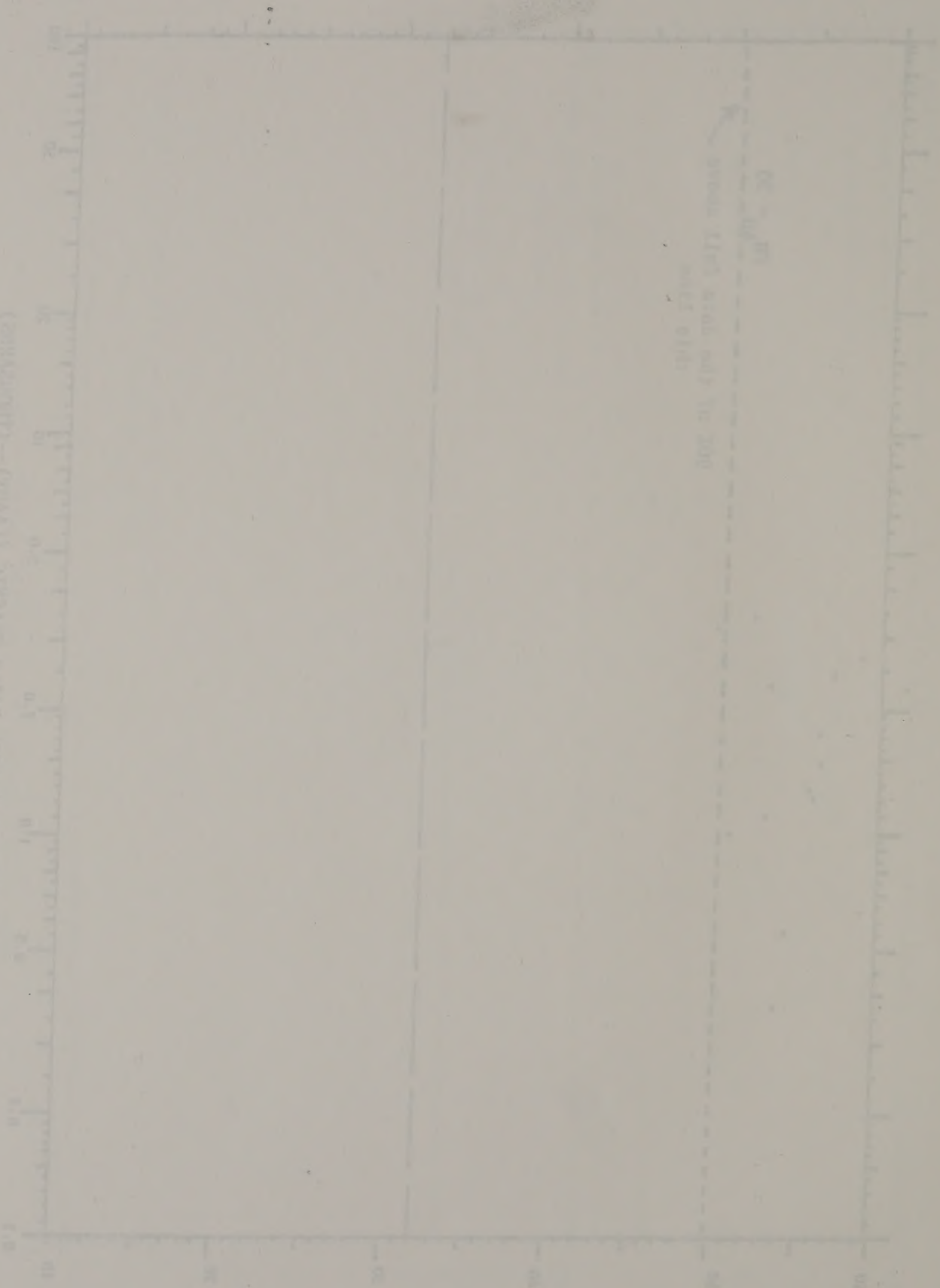


Figure 6 : AVERAGE FRICTION NUMBER (AT 40 MPH) vs AVERAGE DAILY TRAFFIC (LANE AADT)
SANDSTONE (B1a), SILTSTONE (B1b), QUARTZITE (B1c)





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